AIR TRANSPORTATION TECHNOLOGY PROGRAM

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Richard H. McFarland and
James D. Nickum
Avionics Engineering Center
Department of Electrical and Computer Engineering
Ohio University
Athens, Ohio

INTRODUCTORY REMARKS

The Air Transportation Technology Program at Ohio University, supported as a Joint-University Program effort by the National Aeronautics and Space Administration and the Federal Aviation Administration, dedicated the year 1983 principally to producing a specific research tool, viz, a flexible Loran-C receiver.

It was a successful year for the design and testing of the hardware. During 1983 several improvements to the Loran-C research receiver were made to allow this device to function more reliably and to provide a means to achieve flight test data with less difficulty.

Many of the changes to the receiver made in 1983 were natural extensions of the work completed in 1982 at Ohio University. The changes made involved a complete re-packaging of the receiver. The 1983 changes were to the performance and capability of this Loran-C receiver.

The ability to operate the receiver off of a single, simple power supply contained in the receiver was developed. This power supply consists of two switching DC to DC converters that provide + 5 VDC and ± 12VDC from an 8 to 40 VDC input supply system in the vehicle. The switching supplies are 75 to 85% efficient and therefore do not contribute significantly to power consumption of the receiver. Additionally, the complete power supply fits into a double wide slot in the receiver card-cage. This capability allows the entire receiver to be contained in a 19.5 inch rack panel that is only 5.25 inches tall and 9.0 inches deep.

The next change to the receiver that allowed a computation performance improvement was the new timing board design. This permitted a decrease in the time that the processor spent in wait loops. In the previous timing board design the processor had to wait for the digit strobes from the master timing chip to read each of the digits of the Loran-C pulse time. This wasted as much as 200 microseconds for each Loran-C pulse. This has been changed with the addition of hardware to produce an interrupt to the processor when the data from the timing chip is ready for output. Since there are 25 individual Loran-C pulses in the current 3 stations tracked and each pulse requires 5 digits to be read, a significant amount of time was wasted with the older timing board. The improvement with a 9960 GRI is greater than 25% per GRI.

Another hardware improvement involved the ability of the Loran-C receiver to treat all of the received Loran-C stations equally so that determination of the correct track point on the Loran-C pulse was achieved for stations of differing signal strengths. This was accomplished with a multiplexed sampled AGC system. This would allow increased accuracy in the determination of the correct tracking point on the Loran-C pulse. The hardware is complete and ready for integration into the current Loran-C receiver software.

The most significant improvement to the Loran-C receiver involved the implementation of Random Navigation capability (RNAV) in the O.U. Loran-C receiver. This work was completed by Fujiko Oguri as her masters thesis. Her work is summarized here as a paper submitted by Ohio University to these proceedings. Essentially, her work allows a complete implementation of the ability to navigate in a random fashion to any coordinates in the Loran-C coverage volume. The software provides cross-track error on a CDI, distance to go to the next waypoint, cross-track bearing, true course, ground speed and estimated time enroute. The Loran-C receiver with the RNAV software has been flight tested with excellent results.

Of particular significance is the fact that Ms. Oguri's thesis has been recognized by the Radio Technical Commission for Aeronautics (RTCA) through its W. E. Jackson Award for the outstanding technical paper submitted in the annual national competition. This is particularly noteworthy since the 1982 RTCA Jackson Award was presented to Joseph Fischer for his thesis supported by Joint University Program. His paper reported the design of the Loran receiver that was a prerequisite to Ms. Oguri's work with the RNAV. Importantly, both of these individuals have taken jobs in the avionics industry where their experiences with the Joint University Program is directly applicable.

New work that was begun in 1983 included a characterization of path differences for navigation equipment using great circle or rhumb-line course steering computations. Of major concern were the factors that controlled the cross-track path errors and the magnitude of the errors based on those factors. Rajan Kaul worked on a Fortran simulation that provided answers to these questions. This model will be implemented in the O.U. Loran-C receiver so that course steering can be provided based on rhumb-line as well as great circle. This issue of rhumb-line versus great circle becomes significant for situations where vehicles using navigation systems based on these different course computation methods begin to mix.

Additionally, Kaul is developing a microcomputer implementation of a model of the earth's magnetic variation to be included in the Ohio University Loran-C receiver software. This model implementation will allow automatic inclusion of the magnetic variation so that one less manual pilot entry is necessary.

In order to facilitate the necessary pilot data entry, a control display unit (CDU) is being developed for the Ohio University Loran-C receiver. This CDU will have the ability to not only present and absorb data but also to act as a window on other possible sensors and information systems on the aircraft. This is similar to the EFIS (Electronic Flight Instrumentation System) now available for some

aircraft. The CDU is designed to allow easy modification of the data entry and display so that new methods can be investigated with very little significant changes. This will certainly provide the necessary capability of this receiver.

The major purpose of this work is very close to being fully realized. This purpose, again, is to provide a research tool, a receiver, such that engineers interested in examining Loran-C performance, usefulness, and other properties will have a flexible, modifiable, and well-known piece of receiving hardware. Industry will, of course, have the opportunity to glean from the receiver system designs and products those items which will enhance their products and make Loran-C a more efficacious navigation system for the United States aviation community and possibly those communities with marine and land interests.